IP AND OPTICS EVOLUTION

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**IP/OPTICAL INTEGRATION**

**OBJECTIVES**

1. **COMMON SET OF FUNCTIONS ACROSS NETWORK LAYERS**
   - Provide deep integration between
   - Based on deployed data plane, control plane and management plane integration
   - Cost reductions (lower OpEx and CapEx)
   - Maximize GREEN

2. **FROM CONNECTIVITY CAPABILITIES TO PROACTIVE VALUE – HIGH AVAILABILITY**
   - Identify impact of optical fault on IP services
   - Identify which services/customer impacted by Optical fault
   - Integration of Wavelength Tracker and IP OAM status

3. **END-TO-END SERVICE DELIVERY AND MANAGEMENT**
   - Provisioning value – dynamic service delivery
   - Integrated and automated provisioning of IP Services and Optical paths
   - Sharing of SRLG information to ensure path diversity
   - Integrated workflows and templates
   - Zero Touch Photonics management for least cost operations and CAPEX savings
# IP-OPTICAL INTEGRATION

## IPoDWDM
- Optical transponder integration within 7950 XRS & 7750 SR
- 100GE tunable DWDM interfaces
- Wavetracker integration

## INTEGRATED MANAGEMENT
- 5620 SAM offers single management suite across IP edge & core and optical domains
- Greater cross-layer visibility reduces troubleshooting, service turn-up and restoration complexity

## OPTICAL EXTENSION SHELF
- Optical extension shelf (OES) ports
- Provides expanded management and control plane integration capability

## FLEXIBLE OFFLOAD OPTIONS
- VLAN, OTN, port, and wavelength level grooming for the most efficient interconnect options
- Shaped sub-interfaces on 7950 XRS & 7750 SR network ports
### INTERCONNECTTION DATA PLANE OPTIONS
**SERVICE PROVIDERS WITH LEASED LINES**

**Model A**

#### Feature | Model A
--- | ---
Grooming capabilities | • Packet  
• ODU  
• Lambda  

Router interconnect | ETH/VLAN  

Multi-layer protection | ETH-OAM IWK  

Implementation | VLAN, capacity loss due to ETH/OTN  

Control plane interconnection | • GMPLS UNI  
• Static  

Granularity of connectivity | • Port bitrate  
• VLAN/1Kbps jointly with ODU-Flex/1Gbps  

TDM client | True-TDM  

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## INTERCONNECT MODELS
### SERVICE PROVIDERS WITH NO LEASED LINES

<table>
<thead>
<tr>
<th>Feature</th>
<th>Model B</th>
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</thead>
<tbody>
<tr>
<td>Grooming capabilities</td>
<td>• Packet&lt;br&gt;• Lambda</td>
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<tr>
<td>Router interconnect</td>
<td>G.709 Tunable DWDM/G.709</td>
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<td>Multi-layer protection</td>
<td>Rtr to Rtr G.709 OTN layer&lt;br&gt;IP/MPLS resiliency</td>
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<td>TDM client</td>
<td>Packetized TDM</td>
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</table>

**Diagram:**
- **Model B**
  - IP/MPLS
  - Router
  - VSR
  - OTN
- **GMPLS**
  - WDM
  - TDM Client
INTEGRATED NETWORK MANAGEMENT

Service Creation – requires access to two different network management systems, without network layer cross checking, two operational teams

Single network management access to provision services

Single Multi Layer integrated provisioning system
SDN IN TRANSPORT NETWORKS
SDN TRANSFORMATION FRAMEWORK

FROM DISTRIBUTED TO CENTRALIZED NETWORK CONTROL MODEL
Expose network layer state, service control and context awareness allowing differentiating traffic engineering to offering enriched connectivity

FROM INDEPENDENT CONTROL AND MANAGEMENT TO FULLY INTEGRATED UNIFIED NETWORK
Multi layer network unification introduces a richer services more flow granular with less complexity, higher network utilization.

FROM LEGACY NETWORKS TO HIGH LEVERAGE NETWORK™
Transform to one IP network that is converged, scalable, intelligent, multiservice, eco-sustainable … and cost effective
Abstraction hides the complexity of the control plane from the applications/services.

In effect it decouples the applications from the protocols, thereby allowing the applications/services to be implemented in a simple, centralized, extensible way.
BRIDGING THE GAP BETWEEN:
NETWORK APPLICATIONS AND NETWORK

SDN TRANSPORT FRAMEWORK

NETWORK APPLICATION ATTRIBUTES
- Scalable
- Low Latency
- Guaranteed Delivery
- Extensible
- Self Healing

NETWORK LAYERS TECHNOLOGY ATTRIBUTES
- MPLS
- G.709

NETWORK TOPOLOGY ATTRIBUTES
- Openflow is one option

Application Request → Service Mapping → Service Binding

ABSTRACTION LAYER

MPLS

G.709

ABSTRACTION LAYER

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